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Geochemical evidences of trace metal anomalies for finding hydrocarbon microseepage in the petroliferous regions of the Tatipaka and Pasarlapudi areas of Krishna Godavari Basin, India

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Abstract: The long-term seepage of hydrocarbons, either as macroseepage or microseepage, can set up near-surface oxidation reduction zones that favor the development of a diverse array of chemical and mineralogical changes. The bacterial oxidation of light hydrocarbons can directly or indirectly bring about significant changes in the values of pH and Eh of the surrounding environment, thereby also changing the stability fields of the different mineral species present in that environment. The paper reports the role of hydrocarbon microseepage in surface alterations of trace metal concentrations. In this study trace metal alterations were mapped that appear to be associated with hydrocarbon microseepages in the oil/gas fields. A total of 50 soil samples were collected near oil and gas fields of the Tatipaka and Pasarlapudi areas of the Krishna Godavari Basin, Andhra Pradesh. The soil samples were collected from a depth of 2-2.5 m. The paper reports the chemical alterations associated with trace metals in soils that are related to hydrocarbon microseepages above some of the major oil and gas fields of this petroliferous region. Trace metals, such as scandium (Sc), vanadium (V), chromium (Cr), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), barium (Ba) and strontium (Sr), in soil samples were analyzed using inductively coupled plasma-mass spectrometry (ICP-MS). The concentrations of Sc (8 to 40 mg/kg), V (197 to 489 mg/kg), Cr (106 to 287 mg/kg), Co (31 to 52 mg/kg), Ni (65 to 110 mg/kg), Cu (88 to 131 mg/kg), Zn (88 to 471 mg/kg), Ba (263 to 3,091 mg/kg) and Sr (119 to 218 mg/kg) were obtained. It was observed that the concentrations of trace elements were tremendously increased when they were compared with their normal concentrations in soils. The analysis of adsorbed soil gas showed the presence of high concentrations of ΣC_{2+} (C_2H_6, C_3H_8 and n-C_4H_{10}) ranging from 7 to 222 μg/kg respectively. Integrated studies of trace elements over adsorbed light gaseous hydrocarbons (ΣC_{2+}) anomalies showed good correlation with the existing oil and gas wells. The carbon isotopic composition of $\delta^{13}C_1$ of the samples ranges between –36.6‰ to –22.7‰ (Pee Dee Belemnite) values indicate thermogenic origin, which presents convincing evidence that the adsorbed soil gases collected from these sediments are of catagenetic origin. The increase in the concentrations of trace metals near oil/gas producing areas, suggests a soil chemical change to a reducing environment, presumably due to the influence of hydrocarbon microseepage, which could be applied with other geo-scientific data to identify areas of future hydrocarbon exploration in frontier areas.

Key words: Hydrocarbons, microseepage, trace metal alterations, adsorbed soil gas, Krishna Godavari Basin

1 Introduction

Surface geochemical prospecting for hydrocarbons comprises investigation of near surface soils/sediments for occurrence of hydrocarbons that may indicate the location of subsurface petroleum reservoirs. Surface geochemical methods are based on the premise that the component hydrocarbons gases (CH_4, C_2H_6, C_3H_8 and n-C_4H_{10}) migrate to the surface from the sub-surface petroleum accumulations through faults and fractures and leave their signatures in the near surface soils. Many hydrocarbon migration mechanisms such as diffusion, effusion, advection with moving waters and permeation have been proposed and studied by various workers (Price, 1986; Tedesco, 1995; Schumacher and Abrams, 1996). These light gaseous hydrocarbons migrate

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